Unit Plan: SBI3C

C. Microbiology

Students will investigate the diversity of microorganisms through a variety of different lessons designed to facilitate a constructivist learning environment. The practical application, and techniques used in the field of microbiology will also be explored using inquiry based activities.

Accommodations that can be easily integrated into the lesson plans include the availability and use of technology, varying the level of text based material, creating a classroom ‘word wall’, providing extra time to complete assignments or explore stations, and allow for individual or group learning as needed. Having several class computers available is extremely important in considering the needs of all students as typing, reading, and translating software are often a necessity to non-native English speaking learners, as well as learners with identified exceptionalities.

Overall Expectations

By the end of this course, students will:

C1. assess the effects of microorganisms in the environment, and analyse ethical issues related to their

use in biotechnology;

C2. investigate the development and physical characteristics of microorganisms, using appropriate

laboratory equipment and techniques;

C3. demonstrate an understanding of the diversity of microorganisms and the relationships that exist

between them.

Relating Science to Technology,

|  |  |  |  |
| --- | --- | --- | --- |
| **Lesson (Title and topic)** | **Expectation Codes** | **Lesson Strategy and Assessment** | **Evaluation including criteria addressed from Achievement Chart** |
| 1. What is Microbiology? |  | Divide students into five groups. Have each group discuss and record onto chart paper their ideas about these questions: How does a microorganism differ from other organisms? What are the different kinds of microorganisms? Are there any uses for microorganisms? Are there any dangers associated with microorganisms?  Provide students with a checklist of learning goals for the unit. | The purpose of this lesson is to assess for learning so that subsequent lessons can be adjusted based on students’ needs. |
| 1. Prokaryotic Cells: Bacteria and Archaea | C2.2  C3.1C3.2 | Students will complete a series of questions while they explore prokaryotic cells at different stations set up around the classroom. | Questions and responses will be assessed for knowledge and understanding of content. Observations of students (1/2 of the class) initiating and planning skills will be recorded. |
| 1. Eukaryotic Cells: Fungi, Algae, and Protozoa, Oh My! | C2.2C3.1C3.2 | Students will complete a series of questions while they explore eukaryotic cells at different stations set up around the classroom. | Questions and responses will be assessed for knowledge and understanding. Observations of students (2nd ½ of the class) initiating and planning skills will be recorded. |
| 1. The life of a microorganism: Investigating Mitosis and Meiosis | C3.2 | Class will begin with an overview of mitosis and meiosis.  Students will begin an inquiry based assignment using a virtual lab from <http://www.phschool.com/science/biology_place/labbench/index.html> | A KWL chart will be used to asses for learning prior to the beginning of the virtual lab. |
| 1. Continuation of lesson 4. | C3.2 | Students will complete the inquiry based assignment using the virtual lab from the previous session. | The lab assignment will be submitted and assessed for knowledge of content, critical thinking, organization of ideas, and application of knowledge. |
| 1. Part 1-Growing Microorganisms: Investigating Optimal Conditions Part 1 | C2.3 C2.5 | Aseptic technique of inoculating culture tubes and dishes will be demonstrated. Students will work in pairs and select a known microorganism (from those available) and inoculate three sterile culture dishes and three sterile culture tubes. Students will choose a surface to swab and inoculate three sterile culture dishes and three sterile culture tubes. Students will select three locations to store their dishes and tubes (eg. In the refrigerator, by the heater, in a dark cupboard, by the window, etc.) and take note of the physical conditions that may affect the growth of their organisms. | Observations of students will be recorded to assess for application of proper technique, and ability to communicate with their partner. |
| 1. Part 2- Growing | C2.3  C2.5 | Students will make daily observations for 5 days, on the 5th day students will prepare a slide and examine their microorganisms under the microscope. For the unknown microorganisms students will identify which types are present (Bacteria, Fungi, etc.) and try to further identify them with a chart provided by the teacher showing the structure of common microorganisms and what they look like under a microscope. Students will produce a report of their findings. | Report will be assessed for students processing and strategy skills, critical and creative thinking, communication and application. |
| 1. Antibacterial Agents | C2.4 C1.2 | Using the microorganisms produced during the growing experiment students will perform tests of different types of antibacterial agents. Students will select different types of antibacterial agents and apply them to their various cultures. Students will observe immediate and long term effects on both the known microorganism and the unknown microorganisms through observations that occur over the course of one week. Students will move from pairs to squares and use their data to discuss the benefits and possible harmful effects of using antibacterial agents. Squares will present their findings to the class. | Communication skills will be observed and recorded. Class presentations will be assessed for communication and application of data. |
| 1. Pro- or Eukaryotic: Can you name that microorganism? | C3.1 | Lab activity: Working in pairs students are provided a set of slides of microorganisms and must classify the microorganisms on the basis of their characteristics whether they are prokaryotic or eukaryotic. For a challenge students may further classify them as bacteria, algae, protozoa, or fungi. Written explanations for their classification must be given. | Student work will be assessed for knowledge and understanding of content, and thinking processes and strategies. |
| 1. Viruses | C3.1C3.4 | Class will divide into pairs and complete a short activity about the definition of a living organism. A class chart will be made incorporating the findings.  Short lecture about the characteristics, morphology, and reproduction of viruses.  Students will write a one page reflection about whether they consider a virus to be a living or non-living organism. | Reflections will be collected and assessed based on logic, organization of thoughts, creative thinking, and the effectiveness of the application of content. |
| 1. E.coli: Walkerton case study | C1.1C3.5 | Students will explore several stations to learn about the Walkerton Tragedy. Stations will include a culture of non-pathogenic e-coli where they will prepare and examine a slide under the microscope; a reading station with numerous texts and articles about the timeline of the tragedy; and a think tank to debate the benefits of using potentially hazardous materials to grow crops with the dangers of contaminating drinking water supplies | Questions based on the stations will be submitted for assessment based on critical thinking, application, and content knowledge. |
| 1. HIV | C3.4  C3.5 | A case study of the HIV virus will be completed as a jigsaw. Four articles will be provided: 1) the stages of the HIV infection; 2) the transmission of HIV; 3)the distribution of the virus around the world; 4) A look at the life of an HIV positive person receiving treatment  Students will complete one group question and one group member at random will present it to the class. | Students in each group will be assessed equally based on processing and strategy skills, effective application of content, critical and creative thinking. |
| 1. Ringworm | C3.4  C3.5  C2.3 | Students will be required to complete a whole class investigative activity in the computer lab about ringworm.  During the last 20 minutes of this class students will inoculate culture trays with various types of yoghurt in preparation for the next lab. | Assessment will focus on communication and planning and strategy. |
| 1. Intestinal Flora and Yogurt | C1.1  C3.3  C3.5 | Three stations will be completed by students about the role of intestinal flora and the benefits of yogurt. 1) Students will examine the growth on their culture by making slides and viewing them under the microscope. (Have some prepared slides handy in case the students’ slides don’t work well); 2) reading about normal bacterial flora, questions about the diversity of bacteria found in the intestine (why is this diversity important?) 3) Think tank: Consider the effects of antibiotics on the body’s natural bacterial flora  A worksheet will be submitted at the end of the session.  A good resource is <http://www.textbookofbacteriology.net/normalflora.html> | Assessment will be based on application of knowledge, understanding of content, communication of ideas, and the transfer of knowledge and skills. |
| 1. Vaccines | C3.4  C3.5 | Students will explore the history and development of various vaccines and complete questions relating to an inquiry based case study. | Solutions will be assessed for content knowledge and application of knowledge. |
| 1. Treatment Design: How to Terminate a Microorganism | C2.4  C2.5  C3.5 | Class time provided to work on culminating task Part C (Janine: this activity will be attached to the final Unit Package that will be posted for the class) | Discussions with individual students and small groups should focus on any difficulties that they may be experiencing. |
| 1. Biotechnology and Ethics | C1.1  C1.2 | Students will work on debate activity attached at the end of this Unit Plan. | Assessment as indicated in activity outline. |
| 1. Class Presentations (2 hours) | C2.4  C2.5  C3.5 | Individuals and Groups will present Part C of the culminating activity to the class. (8 minutes each)  Ask students to review the learning goals checklist provided during the first session to ensure that they are prepared for the review session. | Presentations will be assessed for completeness of required content and communication skills. |
| 1. What is Microbiology? | C2.1 | Student will review and revise original KWL chart in small groups. Each member will present one finding from the L section of their chart to the class. | Observe and record the interaction of students within the groups. Assessment will focus on communication for different audiences (peer to class). |
| 1. Unit Test |  |  |  |

Lesson 17: Debate Activity

SBI3C-Microbiology

Overall Expectation - C1

Specific Expectation C1.2

Teachers Note: This activity will likely require at least two 60 minute sessions.

**Student Handout**

The article in Appendix A describes the controversy about scientific research that may be potentially dangerous. Your task is to:

1. Read the article and write a brief summary.
2. In your assigned groups using chart paper write as many points as you can about the benefits of biological research studies on one side of the paper, turn the paper over and write as many points as you can about the dangers of biological research studies.

Your summary and chart will be evaluated for your understanding of the ideas presented in the article.

1. Show your chart to the teacher and receive your debate status: either in favour of biological research, or against biological research.
2. Prepare your arguments according to the guideline provided in Appendix B
3. Debate!

Your presentation in the debate will be evaluated based on: The organization of your ideas (does your argument flow well?)

1. The logic of your argument (do your facts support your argument, does it make sense?)
2. The strength of your argument (is it convincing?)
3. Your speaking voice (can I hear you clearly?)
4. Your body language (do you present yourself professionally? i.e. standing straight, not slouching, arms not crossed in front, etc.)
5. Write a journal entry expressing your opinion about whether scientists should conduct research that may have potentially dangerous applications.

Your journal entry will be evaluated based on you understanding of the topic, how you connect the idea of performing biological research to the potential impact on society and the organization of your ideas.

Appendix A

**Governance of dual-use research: an ethical dilemma**

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**Introduction**

In the early days of atomic physics, it was realized that discoveries regarding nuclear fission and the chain reaction might be used for both beneficial and harmful purposes. The scientists involved recognized that, on the one hand, such discoveries could have important applications for medicine and energy production but that, on the other hand, they might also lead to the production of unprecedented weapons of mass destruction.[1](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R1) Foreseeing the potential weapons implications of experimental results regarding the chain reaction, Leo Szilard engaged colleagues in debate about the virtues of self-censorship. If dangerous discoveries were kept secret, he argued, then the development and use of such weapons might be avoided. However, similar discoveries were made and published by other physicists and atomic bombs were subsequently developed and used by the United States of America (USA) during the Second World War. Governmental regulation and censorship of nuclear science has since been common.[2](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R2)

Life science researchers find themselves in a similar situation today. The biological sciences are progressing rapidly and recent developments in biotechnology may have tremendous medical (and other) benefits for humankind. In many cases, however, the same discoveries that promote advancement of medicine could also facilitate production of biological weapons of mass destruction. An unclassified Central Intelligence Agency (CIA) document entitled *The darker bioweapons future* claims that:

“advances in biotechnology … have the potential to create a much more dangerous biological warfare threat … engineered biological agents could be worse than any disease known to man.”[3](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R3)

Though the dangerous implications of contemporary biology had been recognized earlier,[4](http://www.who.int/bulletin/volumes/87/9/08-051383/en/" \l "R4) heightened concern followed the anthrax attacks in the USA in 2001.

There are numerous reasons to take the threat of biological weapons seriously. In comparison with nuclear weapons, the production of biological weapons is relatively easy and inexpensive; and information about how to produce biological weapons is readily available in published scientific literature. In comparison with nuclear science, where discoveries with weapons implications are usually classified, information sharing in the life sciences has traditionally been completely open.[2](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R2) The anthrax attacks in the USA and other recent episodes, finally, have revealed that the threat of bioterrorism is real.

**The dual-use dilemma**

Scenarios where the results of well-intentioned scientific research can be used for both good and harmful purposes give rise to what is now widely known as the “dual-use dilemma” and there has been growing debate about the dual-use nature of life science research in particular. Four recent cases involving the publication of dual-use discoveries have been particularly controversial.

In Australia, researchers inserted the mouse IL-4 gene into the mousepox virus hoping that the altered virus would sterilize mice and thus provide a means for pest control. To their surprise they discovered that they had produced a superstrain of mousepox that killed mice that were naturally resistant to, and mice that had been vaccinated against, ordinary mousepox.[5](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R5) This discovery implies that the same technique might enable production of vaccine-resistant smallpox. Because there is no known treatment for smallpox, vaccination is our only defence. This study was published in the *Journal of Virology* in 2001.

In a second study, researchers at the State University of New York at Stony Brook artificially synthesized a “live” polio virus from scratch.[6](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R6) Following the map of the polio virus RNA genome, which is published on the Internet, they stitched together corresponding strands of DNA, which they purchased via mail-order. The addition of protein resulted in the creation of a virus that paralysed and killed mice. Upon publication of results in *Science* in 2002, the researchers said they “made the virus to send a warning that terrorists might be able to make biological weapons without obtaining a natural virus”.[7](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R7) Similar techniques might enable production of smallpox or Ebola.

In a third study, published in the *Proceedings of the National Academy of Sciences* in 2002, researchers used published DNA sequences to engineer a protein – known as SPICE – produced by the smallpox virus.[8](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R8) The study revealed the ways in which, and the extent to which, this protein defeats the human immune system. Though the findings may facilitate development of protective medicines, they may also reveal ways to increase the virulence of the closely-related *vaccinia* virus (which is used in the smallpox vaccine).

A more recent study, published in *Science* in 2005, employed techniques of synthetic genomics (similar to those used in the polio study) to “reconstruct” the Spanish Flu virus, which killed between 20 and 100 million people in 1918-19.[9](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R9) Though further research on the reconstructed virus may facilitate development of drugs and vaccines that provide protection against a major influenza pandemic, such a virus could also be used for nefarious purposes by malevolent actors.

Each of these studies aroused substantial controversy. Given their implications for making biological weapons, critics complained that these studies should not have been conducted and/or that they should not have been published. Publication of studies like these, they argued, alerts bioterrorists to new ways of producing biological weapons and provides them with explicit instructions for doing so. At the very least, they argued, the materials and methods sections of the published articles should have been omitted or amended.

Though they understood the dangers, the scientists and editors involved defended their actions. Among other things, they argued that these publications would play an important role in alerting the scientific community to the importance of developing protection against newly revealed dangers. In the case of the influenza study, it was argued that medical benefits of publication outweighed the risks associated with terrorism, especially given current concerns about pandemic influenza. In response to suggestions that materials and methods descriptions should have been omitted or altered, they argued that inclusion of such information is crucial to scientific method, i.e. for replication and verification.

**Policy development**

Whether or not these studies and others like them should have been conducted and/or published, they have attracted attention to the problem of dual-use biological research and the potential need for increased governance of science. Dual-use research is a primary area of focus in debates about biosecurity and bioterrorism, and there have been numerous relevant policy developments. In 2003 (before the influenza study), for example, a journal editors and authors group issued a joint “Statement on scientific publication and security” in *Science*, *Nature*, the *Proceedings of the National Academy of Sciences* and the American Society for Microbiology journals. The statement indicated that these journals would screen submissions for “safety and security issues” and that when “harm of publication outweighs the potential societal benefits ... the paper should be modified or not published”.[10](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R10)

In 2004, the USA’s National Research Council (NRC) published an influential report entitled *Biotechnology research in an age of terrorism*, also widely known as “the Fink report”.[2](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R2) Among other things, the NRC called for increased education of the scientific community about the dual-use dilemma; recommended that the role of institutional biosafety committees be expanded to include review of research proposals for dual-use risks (as well as environmental dangers); recommended self-governance of the scientific community (as opposed to governmental censorship) in matters related to publication of dual-use research findings; and called for the establishment of a new advisory board to provide guidance to the government regarding the oversight of dual-use research. Such a body, the National Science Advisory Board for Biosecurity (NSABB), was established in 2004; and its working groups have been developing criteria for identifying dual-use research of concern, tools for controlling dissemination of information, science codes of conduct, policy recommendations regarding synthetic genomics and means for international collaboration in the oversight of dual-use life science research.[11](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R11)

The NSABB has also played a role reviewing papers raising dual-use issues. The above-mentioned influenza study, for example, was sent to the NSABB for review before publication in 2005, and members voted unanimously that the paper should be published. The editor-in-chief of the journal, however, subsequently wrote that he would have published the study even if the NSABB had voted otherwise.[12](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R12) This highlights the fact that the status quo in the USA (where dual-use life sciences research has received the majority of attention) relies on voluntary self-governance of the scientific community in matters of censorship, as recommended by the NRC. Referral of papers to the NSABB is voluntary and its decisions are not legally binding.

It is questionable, however, whether reliance on voluntary self-governance of the scientific community in matters of censorship is advisable. Because scientists generally lack training in security studies, they may lack the expertise required for assessment of the security risks of publication in any given case. This point is especially well illustrated by the mousepox experiment. Assessing the security risks of the mousepox publication requires knowledge about the likely proliferation of the smallpox virus (e.g. from alleged former Soviet bioweapons stockpiles) because would-be bioterrorists would need to have access to the smallpox virus to apply the mousepox genetic engineering technique to it (if their aim is to produce vaccine-resistant smallpox). Detailed information about the likelihood of smallpox proliferation, however, is classified information held by intelligence and security experts (if anyone). In the case of the mousepox study, scientists (lacking security clearance) are systematically denied access to information essential to assessment of the security risks of the relevant publication.[13](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R13)

A second reason for doubting that voluntary self-governance of scientists in matters of censorship would be appropriate is that conflicts of interest arise insofar as publication is crucially important for career advancement in science. A final reason is that the dual-use dilemma potentially involves conflict between the promotion of security and the progress of science. In cases where publication of scientifically important dual-use research conflicts with security, neither the goal to promote security nor the goal to advance science should be given (absolute) priority over the other. Both scientific progress and security matter; in cases of conflict a balance should be struck between the two. Given what they do for a living, however, it is likely that the values of scientists will be biased in favour of science over security.

A system involving governmental control over publication practices, on the other hand, may promote security; but this would have costs in terms of academic freedom. Scientific progress may also be hindered (to the degree that, as is often claimed, scientific freedom is essential to scientific progress). The scientific community is right to be wary about governmental censorship. Given what they do for a living, bureaucrats and security experts are likely to be biased in favour of security values over scientific values. There is also reason to doubt that governmental decision-makers will always have sufficient expertise to judge the scientific importance of publishing studies they might want to censor. An additional worry about the censorship of science by government is that this could be one more step down the path of liberty infringement in the name of “the war on terrorism” and that governmental censorship may threaten freedom of speech more generally.

**Ethics**

To the extent that important values are at stake, the dual-use dilemma is inherently ethical in nature.[14](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R14) It is noteworthy, however, that most of the debates about the dual-use dilemma have primarily involved science and security experts rather than ethicists. Bioethicists have to date had relatively little to say about security in general or the dual-use dilemma in particular.[13](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R13),[15](http://www.who.int/bulletin/volumes/87/9/08-051383/en/" \l "R15) This is ironic given the enormous amount of attention bioethics has placed on both: (i) research ethics, and (ii) ethical, legal and social implications of genetics. Research ethics discourse has predominantly focused on the protection of human and animal research subjects, and research ethics guidelines rarely mention problems posed by dual-use research.[16](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R16) The literature on ethical implications of genetics has focused on potential environmental hazards of recombinant DNA research, genetic determinism, genetic testing, discrimination by employers and insurance companies, selective reproduction, genetic enhancement, cloning, stem cell research, DNA fingerprinting and the patenting of DNA sequences.[13](http://www.who.int/bulletin/volumes/87/9/08-051383/en/#R13) At the time of writing this paper, a huge number of journal articles and books on ethics and genetics had been written; but they include little, if any, discussion of the potential role of genetics in weapons-making.

Robert Cooke-Deegan’s canonical history of the human genome project, *The gene wars*,[17](http://www.who.int/bulletin/volumes/87/9/08-051383/en/" \l "R17) includes explicit coverage of the politics and ethical debate surrounding the new genetics. Despite all the links that are drawn between genetics and atomic weapons, and despite inclusion of a chapter entitled “Genes and the bomb”*,* the book never mentions discussion or debates about the implications of genetics for biological weapons development. It is commonly said that the power of genetics is comparable to the power of atomic physics and that we need more ethical discussion and reflection about the former than the latter received when the first atomic bombs were made and used – the idea being that more socially responsible decisions about science should be made in genetics than have been made in the context of nuclear energy. The usual discourse on ethical, legal and social implications of genetics, however, reveals that the power of genetics with regard to weapons development is not what those concerned with the ethics of genetics have usually had in mind. If the previously mentioned claims of the CIA are true – as seems plausible in the light of the examples considered above – then biological weapons development may turn out to be one of the most serious consequences of the genetics revolution in biology. It is thus crucially important that there is more ethical input into debates about the governance of dual-use research. ■

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Appendix B

Debate Guidelines

* 1. Each team (groups of 3) will prepare a 4 minute argument
     + 2 minute opening statement- State your position (Are you for or against the research) and why, include at least three strong points. Use factual information to back up your points.

**Each team will present their opening statements to the judge. Remember that you are trying to convince the judge that you have the stronger argument. You will not direct your argument to your opponent but will be speaking directly to the judge.**

* + - 1 minute rebuttal – This is where you will anticipate your opponents arguments. Think about what points they will use to convince the judge that their argument is better. Attack the points of your opponent using factual information to back you up.

**You will have 5 minutes after hearing your opponents opening statement to revise your rebuttal. You will be presenting this argument to the judge to convince them that your opponents’ argument is weak.**

* + - 1 minute conclusion- This is your final chance to convince the judge you’re you have the stronger argument. Restate your position, your strongest points and your opponents’ weakest points.

**The concluding statements will be presented immediately after both teams have presented their rebuttal.**

* 1. Each member of the team will present one part of the argument.
  2. Your will lose points for going over your time limit or under your time limit for each 10 second interval.
  3. A timekeeper will notify you of the time remaining for your argument by raising their hand when there are 30 seconds remaining, and standing when there are 10 seconds remaining.

SBI3U-Microbiology

Culminating Activity- Microorganisms and Human Health

This culminating task is intended to guide the student through a process of learning about microorganisms through a research based approach using the overarching theme of how microorganisms affect human health. Students will have the opportunity to demonstrate and apply their understanding of both prokaryotic and eukaryotic cells by creating a variety of products. Products include creating knowledge based models, investigating questions about how various microorganisms survive and how they affect human health, applying their knowledge to create a product to eradicate an organism that is detrimental to human health, and presenting their findings orally and visually to various audiences while introducing them to the creation and use of academic poster presentations.

The task is broken down into discreet activities designed to be completed as various topics are learned throughout the unit. The task can be introduced at the beginning of the unit and students can begin to work on product A once they have learned about the difference between eukaryotic and prokaryotic cells. You should anticipate that approximately 6 classes of the unit will be required to complete all of the activities, however the number may be lower if you assign some of the work for students to complete on their own time. The Ministry Expectations that are covered by this activity are as follows:

Overall Expectations

C1. Assess the effects of microorganisms in the environment, and analyze ethical issues related to their use in biotechnology;

C2. Investigate the development and physical characteristics of microorganisms, using appropriate laboratory equipment and techniques;

C3. Demonstrate an understanding of the diversity of microorganisms and the relationships that exist between them.

Specific Expectations

C1.1. assess some of the effects, both beneficial and harmful, of microorganisms in the environment

C2.1 use appropriate terminology related to microbiology

C2.4 investigate the effect of antibacterial agents on different bacterial cultures

C2.5 investigate and analyze the conditions needed by microorganisms for growth

C3.1 describe the anatomy and morphology of various groups of microorganisms

C3.2 explain the differences between the life cycles of eukaryotic and prokaryotic microorganisms in terms of cell division

C3.3 explain the vital roles of microorganisms in symbiotic relationships with other organisms

C3.5 describe how different viruses, bacteria, and fungi can affect host organisms, and how those effects are normally treated or prevented.

For the Student

Microorganisms can be both beneficial and detrimental to human health. Your task is to select one eukaryotic and one prokaryotic microorganism to study on the basis that one is beneficial and the other detrimental to human health. You will complete the following tasks based on your study of the microorganisms that you select. Please refer to the rubrics provided and use the checklists included to guide your work.

You may work individually or in pairs.

Activities to Complete

1. Choose one eukaryotic and one prokaryotic microorganism, be sure that one is beneficial to human health and one is detrimental to human health. Create a model of the structure for each microorganism that you have chosen. The models could be 2D or 3D. Be sure to clearly label each part of the microorganism. Include a description of the function of each part of the microorganism. You will be using your model in a poster presentation in part d of this assignment.

To help get you started visit this website:

<http://www.healthhype.com/microorganisms-types-harmful-effects-on-human-body-pictures.html>

1. Answer the following questions about each microorganism:
   1. How does this organism affect human health?
   2. What are the optimal growth conditions?
   3. Considering optimal growth conditions where might this organism thrive in the environment? Where would this organism struggle to survive?
   4. Consider the benefits (or negative effects) that your microorganism has on human health. Are there any other potential applications for this microorganism besides benefitting (or not benefiting) human health?
2. A treatment for a microorganism is something that is designed to kill it or prevent it from reproducing. For example antibiotics are a treatment that we use for illnesses caused by bacteria that act on the bacteria by killing them or preventing them from reproducing. Design a hypothetical treatment for the detrimental microorganism that you chose to study. Your treatment should be designed so that it disrupts some point in the life cycle or reproductive cycle. You must include a statement considering how your treatment will affect the host and how the treatment will be administered (topical, ingested or inhaled). Prepare an 8 minute presentation for the class which will include: a summary of the structure and function of the microorganism, an explanation of the reproductive cycle, how your treatment acts on the microorganism, and the potential effects of the treatment on the human host.
3. Transfer your research from parts B and C into a Poster Presentation (visit <http://www.ncsu.edu/project/posters/NewSite/index.html> to learn more about poster presentations). The models from part A and your poster presentation will be on display during science week in the auditorium. You will each take a turn standing at your poster and presenting your ideas to parents, teachers, and students visiting from other schools.
4. If you worked with a partner: Each person will write a one page summary describing the decision making process of the pair and how the work was divided (who did what).

Checklists

Product A-The Model

* One cell is eukaryotic
* One cell is prokaryotic
* One is detrimental to human health
* One is beneficial to human health
* All cell components are included
* The function of each component has been listed
* The model is neat and it is easy to identify each component

Product B-The Questions

* All questions have been answered
* Answers provide enough detail that any person could understand the message without knowing what the question was
* You have proof read your answers for spelling and grammar

Product C-The Treatment

* Do I understand the life cycle and reproductive cycle of my microorganism?
* Is my treatment designed to disrupt the life cycle or reproductive cycle of my microorganism?
* Have I considered how my treatment might affect the host?
* Is my presentation organized (introduction-body-conclusion)
* Is my presentation 8 minutes in length?
* Have I included all of the necessary components in my presentation:
* a summary of the structure and function of the microorganism
* an explanation of the reproductive cycle
* how your treatment acts on the microorganism
* the potential effects of the treatment on the human host.

Part D-The Poster

* I have visited the website <http://www.ncsu.edu/project/posters/NewSite/index.html>
* The poster includes appropriate headings (e.g. Introduction, Treatment Process, Reproductive Cycle of E.Coli, etc.)
* The poster includes a good balance of text and images
* My research has been summarized completely on my poster
* I have edited all of the poster text for spelling and grammar
* I have included citations for all of the material that I used in my research
* I understand all of the information on the poster
* I am able to explain the information on the poster

Product A

|  |  |  |  |
| --- | --- | --- | --- |
| Level 1 | Level 2 | Level 3 | Level 4 |
| Model is missing cell components, is disorganized and difficult to understand.  The function of the cell components is incomplete. | Model is missing some cell components.  The function of each cell component may be missing or incorrect. | Model includes all cell components  The function of each cell component is correctly listed. | Model includes all cell components, is neat, visually pleasing and organized.  The function of each component is correctly listed. |

Product B

|  |  |  |  |
| --- | --- | --- | --- |
| Level 1 | Level 2 | Level 3 | Level 4 |
| Many answers not correct in content.  Ideas are not always clearly expressed and organization of information is lacking. | Some answers not be correct in content.  Ideas are understood but may not be clear. Information could be organized more effectively. | Answers are correct in content and a considerable understanding of the content is demonstrated. Ideas are expressed logically and information is organized. | Answers are correct in content and knowledge of content is effectively demonstrated.  Ideas are presented logically and information is well organized. |

Product C-Treatment Design

|  |  |  |  |
| --- | --- | --- | --- |
| Level 1 | Level 2 | Level 3 | Level 4 |
| Knowledge is applied with limited effectiveness.  Treatment design may not be logical. Limited demonstration of critical thinking to solve the problem.  Demonstrates how the treatment will affect the organism. May not demonstrate how the treatment will affect the host. | Knowledge is applied with some effectiveness. Treatment design is mostly logical and critical thinking was demonstrated. Demonstrates how the treatment will affect the organism and host with some degree of effectiveness. | Knowledge is applied with considerable effectiveness. Treatment design is logical and creative and critical thinking was used to solve the problem.  Effectively demonstrates how treatment will affect organism and host. | Knowledge is applied with a high degree of effectiveness  Treatment design is logical, creative, and it is clear that critical thinking was effectively used to solve the problem. Effectively demonstrates how treatment will affect organism and host. |

Product C-Presentation

|  |  |  |  |
| --- | --- | --- | --- |
| Level 1 | Level 2 | Level 3 | Level 4 |
| Presentation is disorganized.  Is over or under time 3m or greater either way.  Does not communicate information effectively. | Presentation is somewhat organized. May have difficulty with sequence and flow.  Is over or under time limit 2m either way.  Communicates information with limited effectiveness. | Presentation is organized, has a logical sequence and flow.  Stays within time limit 1m either way.  Communicates information clearly. | Presentation is very well organized, has a logical sequence and flow.  Stays within time limit 30s either way.  Communicates information clearly and effectively. |

Product D-Poster

|  |  |  |  |
| --- | --- | --- | --- |
| Level 1 | Level 2 | Level 3 | Level 4 |
| Information is not organized making it very difficult to understand the content. Poster is visually unbalanced (too much/little space used, too much text, etc.) | Information is somewhat organized but it is difficult to follow the content.  Poster is somewhat visually unbalanced | Information is organized and content is easy to follow.  Poster is visually pleasing. | Information is highly organized and content is easy to follow. Poster is visually striking. |

Product D-Poster Presentation

|  |  |  |  |
| --- | --- | --- | --- |
| Level 1 | Level 2 | Level 3 | Level 4 |
| Demonstrates little knowledge of poster content and is not effective at communicating with different audiences. | Demonstrates some knowledge of poster content and is able to communicate this to different audiences with some degree of effectiveness. | Demonstrates considerable knowledge of poster content and is able to communicate this information with different audiences. | Demonstrates a thorough understanding of poster content and is able to effectively communicate this information with different audiences. |

SBI3C Microbiology Unit Test

**Instructions**: There are twelve questions on the test and they are divided into four sections: Multiple Choice, Definitions, Short Answer, and Application. Be sure to **read through all of the questions carefully** so that you are answering the question being asked. You may use point form and will not lose marks for spelling mistakes. The test is out of 50 possible marks and the mark breakdown is shown below. You have 70 minutes to complete the test.

Section 1-Multiple Choice /8

Section 2-Definitions /5

Section 3-Short Answer /18

Section 4-Application /19

Total /50

# Section 1-Multiple Choice

Select the best answer. Some questions ask you to explain your answer.

1. Which of the following is **not** a characteristic of fungi: /2

**Explain your choice**

* 1. Have ability to reproduce asexually and sexually
  2. Eukaryotic
  3. Colonial cellular arrangement
  4. Chemoheterotrophic

Explanation: Fungi can have unicellular, filamentous, or fleshy cellular arrangements but not colonial cellular arrangements.

1 mark for correct choice

1 mark for correct explanation (K/U, T)

1. What was the source of E. coli during the Walkerton Tragedy?

**Explain your choice.** /2

* 1. raw chicken
  2. canned ham
  3. Runoff of manure from a local farm
  4. Shellfish

Explanation: E.coli entered the town water supply after a period of heavy rains caused runoff from a local farmer’s field to drain into a town well. The runoff water was contaminated with E.coli from manure that was spread on the field.

1 mark for correct choice

1 mark for correct explanation (K/U)

1. Which of the following statements is **true**: /1
   1. Meiosis involves crossing over between homologous chromosomes
   2. mitosis results in haploid daughter cells
   3. mitosis occurs during binary fission
   4. meiosis only occurs in prokaryotic cells

1 mark for correct choice (K/U)

1. Bacteria reproduce by: /1
   1. Binary fission
   2. Mitosis
   3. Meiosis
   4. Endospores

1 mark for correct choice (K/U)

1. An organism that grows best in salty conditions is known as: /2

Explain your choice.

* 1. A mesophile
  2. A thermophile
  3. A halophile
  4. An extremophile

Although a halophile could be considered an extremophile because it grows under extreme conditions the more specific name for this type of organism is halophile.

1 mark for correct choice

1 mark for logical explanation (K/U, T)

# Section 2-Definitions

1. Define only 5 of the following terms.

/5

Intestinal Flora-the diverse range of bacteria that inhabit the intestinal tract

Microbiology-the study of microorganisms

Microorganism-a living organism too small to be seen with the naked eye

Vaccine-A preparation of killed, inactivated, or attenuated microorganisms to induce artificially acquired immunity

HIV- human immunodeficiency virus; a retrovirus that causes AIDS

Bacteria-Kingdom of prokaryotic organisms, characterized by peptidoglycan cell walls

Pathogen-a disease causing organism

Motility-the ability of an organism to move by itself 1 mark for each correct definition (K/U)

# Section 3-Short Answer

1. Complete the following chart indicating the **differences** between prokaryotic and eukaryotic organisms: /8

|  |  |  |
| --- | --- | --- |
| Characteristic | Prokaryotic | Eukaryotic |
| Cell Wall | Complex, contain peptidoglycan | chemically simple, no peptidoglycan |
| Membrane enclosed organelles | absent | Present, e.g. lysosomes, mitochondria |
| Nucleus | No true nucleus | True nucleus |
| Reproduction | Binary Fission | Usually divide by mitosis |

1 mark for each correctly completed cell (K/U, T)

1. Explain the difference between a bacterial endospore and a fungal spore. /4

A bacterial endospore forms inside a bacterial cell in response to adverse environmental conditions. This is not a method of reproduction rather it is a method of preservation of the cell.

Fungal spores are a reproductive structure that can be either asexual or sexual. Fungi can be identified based on spore type.

2 marks for each description (K/U, T)

1. Why do antibiotics kill bacteria but not human cells? Provide one specific antibiotic example and describe how it works on the bacterial cell. /6

Bacteria, unlike human cells, contain peptidoglycan in their cell walls they also have different metabolic processes than human cells. These cellular differences are what make human cells resistant to antibiotics while bacterial cells are killed or prevented from multiplying.

Penicillin interferes with a cells ability to synthesize peptidoglycan which is necessary for bacteria to build a strong cell wall. Without the strong cell wall, the cell bursts and is destroyed.

Sulfonamide antibiotics act to prevent microorganisms from reproducing by inhibiting their ability to synthesize folic acid. Folic acid is necessary for the survival of the cell and therefore the cell cannot reproduce and eventually dies. Human cells are unaffected as they are able to take in folic acid through diffusion.

2 marks for correct response to first question

2 marks for correct example (K/U, T, A)

# Section 4-Application

1. Do you think a virus a living or non-living organism? Provide evidence that supports your argument. Using opposing evidence, describe why some people argue against what you think. /5

Living

Contain DNA-the building blocks of life

Like other living organisms they evolved

Has the potential to reproduce

Non-living

Cannot reproduce independently

Require energy from the host to perform metabolic processes

Exhibit no activity indicative of life when not in contact with host

1 mark for each factual logical point in the argument up to five points (T/I, A)

1. What causes food poisoning? Using your knowledge of optimal growth conditions and food handling explain how you can prevent food poisoning caused by fresh food products. /8

Food poisoning is caused by consuming food products that is contaminated with certain bacteria that are harmful to human health such as E.coli and Salmonella.

2 marks for describing causes of food poisoning

The growth of bacteria on foods can be limited by manipulating optimal growth conditions such as temperature and oxygen requirements. It is also necessary to observe proper food handling techniques to prevent the spread of bacteria from one location to another. It is through manipulating these conditions that food poisoning can be prevented.

2 marks for describing optimal growth conditions

Fresh food is stored using Refrigeration as this acts to manipulate the environmental temperature. The temperature is reduced thereby inhibiting further growth of microorganisms present on food.

Placing food in sealable containers limits the amount of oxygen available to microorganisms and therefore limits their growth.

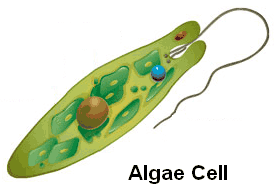
Cooking food at high temperatures also acts to kill certain types of harmful bacteria.

Washing hands and ensuring that cross-contamination of cookware does not occur is important to limit the spread of contaminants such as Salmonella from raw chicken.

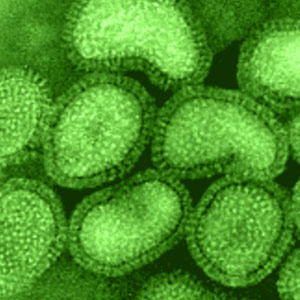
4 marks for explanation about how to use optimal growth conditions to prevent food poisoning

(K/U, T, A)

1. Classify the following cells as Algae, Fungi, Bacteria, or Virus. Explain your classification choice based on the characteristics of the cells. /6



Algae: green colour indicates presence of chloroplasts (photosynthesis); eukaryotic as indicated by presence of nucleus

* 1. 

Virus: protective shell enveloping the cell with possible spikes, no visible nucleus or any type of internal structure

1 mark for each correct classification

2 marks for explanation that matches students’ classification (do not penalize if classification is wrong as long as the explanation corresponds to the students’ choice of classification)

(K/U, A)